# APPENDIX F

# PHYSICAL SCIENCE REPORT

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## I. Chapter 3 - Existing Condition

### A. Soils and Geology

Ninety three percent of the Rough and Ready watershed is underlain by ultramafic peridotites and serpentenites (West Fork Watershed Analysis, (WF WA) pg 12). These rocks are part of the larger Josephine Peridotite Sheet (Hotz, 1964). The Josephine sheet is one of the largest mapped and is approximately 75 miles long, 11 to 16 miles at its widest and tapers to 0.5 to 3 miles near its southern extent in Northern California (Hotz, 1964). The remaining 7 percent of the watershed is underlain by granitic intrusions in the headwaters, by metasediments of the Galice Formation along the eastern boundary, and by undifferentiated alluvium that forms a large fan near the mouth (WF WA, pg 12).

The soils of this watershed fall into the general association ‘Dubakella, Pearsoll, Eightlar’ as mapped in the Josephine County Soil Survey (1981). This association is noted for its well drained, stony character and variable depths that range from shallow to deep (ibid, pg 9). Generally, the Pearsoll soils occupy the ridges and are more shallow and more stony than the Eightlar and Dubakella. Depth to bedrock will vary with location and follows the soil depth. This variable is important in that the soil ground waters likely move largely independently of the deeper ground waters moving through bedrock.

Permeability is slow in all soils. Organic content ranges from 3 to 10%. The surface layer (topsoil) is a stony clay loam and generally very shallow (2-10"). This topsoil contains a high percentage of rocks greater than 3" in diameter (25-75%). The sub-soil in these associations is generally even more rocky than the surface layer.

The West Fork watershed analysis displays a map that characterizes the parent material and estimated soil depths for the watershed (WF WA, pg 13). A second map that displays the fine fraction content of the sub-soils is also displayed; this map is intended to help locate those places in the watershed that may supply fine sediment in the event of disturbance. The very high magnesium content and very low calcium content of these soils limits plant growth (ibid, pg 9; Coleman and Krukebeg, 1998 unpub).

Of particular interest to this analysis are the nickel, chrome and cobalt -rich soils known as laterites.  These residual soils lie on an old 'upland weathered surface and in lower slump and benches as well as in outwash deposits mixed with sand and gravel on the valley floor' (Ramp, 1978). Laterites are generally formed under warm, wet conditions over many, many years (Bates and Jackson, 1979).

The proposed plan of operations that is driving this analysis includes four locations for pit development. These areas were sampled by the Inspiration Development Company from 1973 to 1978 (Ramp, 1978). The data obtained by Inspiration are proprietary and not available. Very limited sampling was conducted by the State of Oregon and the US Bureau of Mines in the vicinity of the proposed pits. These data are presented here to give some representation of the area, but may not reflect actual site conditions.

| **Location** | **Maximum depth to Bedrock (ft)** | **Average depth to Bedrock (ft)** | **Percent rock in laterite soil** |
|---|---|---|---|
| Near Site A | 40 | 10 | 40 |
| Near Site B | 25 | 8 | 45 |
| Near Site C | 16 | 6.5 | 45 |
| Near Site D | 20 | 7 | 35 |

The nickel content in the soil varies by site but ranges from 0.57-1.23%, cobalt from 0.07 to 0.14%, and chrome from 1.06-2.56%. Review of Ramp's map suggests that the proposed pits have been placed in the locations that have the higher of the known nickel contents. Ramp notes that there are several hundred more acres in bench soils as well as over a 1000 acres of outwash that also contain nickel, chrome and cobalt.

The presence or absence of asbestos in the project area has been the subject of some concern. Weathering of periodite into serpentinite and serpentine minerals can very commonly include chrysotile (asbestos), lizardite, brucite, and magnetite (Coleman, 1998). "Epidemiological studies show that the chrysotile asbestos free of amphilbole fibers are not ...linked to mesothelioma" (McDonald and McDonald, 1995 in Coleman, 1998). The presence or absence of amphibole in the serpentinites of Rough and Ready Creek is not known. Telephone conversations with Dr.'s Gregory Harper and David O'Hanley, both experts in the geology of SW Oregon and in Serpentines overall were conducted in the late Winter of 1999.

Dr. O'Hanley suggested that sheared zones be surveyed for the presence or absence of fibrous serpentine minerals. Field samples have shown largely platy, not fibrous minerals in these shear zones, but this small amount of sampling can not be construed as representative. Dr. O'Hanley did not believe that conditions in the area were present such that large quantities of asbestos could form. He did find one exposure down on the Smith River near Patrick's Creek Lodge. Exposure to the asbestos occurs not in the laterite soils, but in the altered peridotites (serpentines). Serpentinites are present throughout the watershed.

The presence or absence of sulfides in the project area has been the subject of some concern. Sulfides are a concern because of the interaction of sulfur with water that produces acidic conditions often referred to as 'acid mine drainage'. The massive sulfide deposits in Josephine County are generally associated with basaltic or more silicic volcanic rocks (Ramp, 1979). These conditions are not met on the periodites of the Josephine Sheet. There are no known sulfide deposits in the Rough and Ready watershed (Koski and Derkey, 1981).

The dominant erosion process in this watershed over long time scales is large landslides (WF WA); gullying and rill erosion are more important on shorter time scales. There are at least 16 miles of road within the project area, most of which can not be driven. There are two places on Rough and Creek mainstem and six places on tributaries that can be forded by high clearance vehicles. These roads and crossings contribute small, but generally not measurable quantities of sediment to the stream system. The dominant erosion processes on these surfaces are surface wash and rilling.

B. Channel Form, Riparian Ecosystems

Rough and Ready creek tumbles out of its headwaters at steep gradients down through a relatively narrow and incised canyon. This pattern gives way to a more meandering pattern before finally spilling into a braided channel as it crosses its alluvial fan (WF WA, physical science report, pg 3). The channel bed is dominated by cobbles and boulders. Deep pools cut into resistant bedrock alternate with much more extensive lengths of riffle and shallow pools.

The role of large wood in this watershed figures far less prominently than it does in other local watersheds. Large wood is generally only found growing in a narrow riparian strip (WF WA). Once it falls, it does meter the flow of sediment in tributaries, but the water power in the mainstem reduces its function and simply carries the wood along as it does the rocks. Accumulations of wood are seen where it has become entangled with riparian vegetation on channel banks and gravel bars. Likely it improves local growing conditions at these locations. Port-Orford Cedar is present in this watershed and is one source of large and rot-resistant wood. It too is most important for metering the flow of sediment in the tributaries.

Any stream side vegetation that blocks or limits solar radiation from the water surface helps to prevent water warming during the critical summer months.

Numerous springs emerge along the length of the channel. Many of these spring from channel banks, others come as through-flow in the extensive gravels. These springs are often recognizable due to abrupt changes in vegetation that is localized to the effluent. The largest spring complex in the project area known to this author is located near the vicinity of proposed crossing 3. These springs appear at the edges of a large gravel bar and appear to be fed both by tributaries that go sub-surface (No-name creek) and by throughflow from the main stem of Rough and Ready itself. There is another spring that is home to a population of yellow-legged frogs near crossing #6 (the most upstream of the 2 currently well-established fords). Flow into this wetland appears to have been disrupted by the presence of the road. It is not known exactly what effects this road may have had or still be having upon the area.

Other springs are located along hillslopes. These are likely fed by water percolating along shear and/or fracture zones in the bedrock (WF WA, physical science report, pg 4). The most notable of these is located just downstream of proposed crossing #3 on the hillslope above the creek. There are also several springs located on the east facing hillslope below proposed mine site B. These spings are likely fed by deeper groundwater recharge and are used for domestic water supply.

There are other streams that drain the project area, namely Rock Creek, Woodbury Creek and numerous unnamed tributaries in Section 27. These creeks drain to the West Fork of the Illinois River. There is little specific data about these creeks. Review of topographic maps and air photos suggests that they are steep, sparsely vegetated (similar to tributaries in Rough and Ready), very likely as ‘flashy’ in response to precipitation. There has been some historic road-building and prospecting in Rock Creek.

## C. Surface and Ground Water Interactions

The term ‘hyporheic zone’ refers that portion of the groundwater interface where a mixture of surface and groundwater can be found (Dahm and Valett, 1996). This area is important to stream ecologists and to those seeking to understand the transport of elements through stream systems. It is particularly relevant to this project in regards to concerns about hazardous materials that could enter the waters of Rough and Ready and be transported to users of ground and surface water.

The hyporheic zone in Rough and Ready Creek has not been studied. Observations of lower flow volumes near the mouth of R&R than those observed higher in the stream system have led many to consider R&R a 'losing' system (WF WA). This observation extends beyond the loss of water that can be attributed to diversions, which also reduce flow volume as one moves downstream. Observers believe that the surface waters of Rough and Ready are recharging the ground waters locally. There are no data about the depth of this hyporheic zone, its function during wet versus dry season, nor its relationship with the deeper groundwater.

The depth to groundwater will vary over the project area. The deeper recharge to regional groundwaters occurs through the bedrock. More shallow ground waters are also present in the soils, and are often 'perched' on the bedrock/soil interface. Depth to these water tables will vary seasonally and during storm events. Drainage from the soil waters into the deeper ground waters occurs, generally at rates that are slower than within-soil drainage rates. While these basic processes are understood to be taking place within the R&R watershed, there is no specific information about groundwater depth. One drinking well of a resident who lives on the alluvial fan is reported to be over 100' deep (WF WA).

## D. Water Quantity - Flow

Streamflow varies by tributary and by season (WF WA, physical science report, pg 8). Generally, the area is noted for its 'flashy' nature, marked by a rapid rise and fall in stream flow in response to precipitation. Summer flows are often critically low, the stream goes sub-surface in several locations in many years.

There are very few flow measurements that have been taken on Rough and Ready Creek. In the summer of 1997, however, Oregon Department of Water Resources, Josephine County branch took the following data:

| | | |
|---|---|---|
| R&R near Mouth | May 16 | 48.7 cfs |
| | June 6 | 41.9 cfs |
| R&R below Seats Dam | May 16 | 39.3 cfs |
| | June 6 | 50.1 cfs |
| | July 2 | 16.6 cfs |
| | July 18 | 9.8 cfs |
| | Aug 15 | 3.6 cfs |
| | Aug 29 | 4.3 cfs |

Stream flow is used to support numerous beneficial uses in the area. According to data collected by the Oregon Department of Water Resources, there are recorded water rights for domestic use, stock, irrigation, and fish. The largest withdrawal occurs at Seats Dam, the right is for 2 cfs for manufacturing purposes. More than 1 cfs is allocated for the Wings and Ferron Ditch, purposes reserved for use are stock and irrigation. The ditch on the south side of R&R draws 1.03 cfs for irrigation use. One site for 0.005 cfs is issued for domestic use. An approximate estimate of allocated uses in this watershed totals a little more than 4 cfs.

E. Water Quality - Sediment

The most striking aspect of water quality noted by observers of R&R creek is its exceptional water clarity (WF WA). This is generally attributed to the rocky, well armored soils and relative lack of disturbance in the area. As discussed previously under section A. Soils and Geology, while large landslides supply the greatest amount of sediment to the channel over long time frames, gullying and sheetwash supply sediment over shorter time frames. Sediment is supplied to the channel via natural processes such as landsliding, bank erosion, sheetwash, and soil creep. Additional sediment is likely also derived from disturbed surfaces such as roads and trails in the watershed. Rates and volumes for these delivery mechanisms are not known.

Water quality in the West Fork is also generally good, although not as clear as observed in Rough and Ready. The exact sources of the sediment pollution in the West Fork is not known, but roads, stream side slides and channel bed and bank erosion are likely. It is not known if Rock, Woodbury and the tributaries in Section 27 are currently sources of sediment to the West Fork. The 4402-461 does show evidence of gullying and subsequent water and likely sediment delivery to the West Fork.

Existing rates of sediment transport along the bed of Rough and Ready were modeled in an attempt to characterize the existing situation. The location chosen for modeling was a stream cross-section located immediately down stream of the lowermost existing ford (proposed crossing #4). The simulated flow level for the modeling exercise was bankfull flows, or those flows expected to occur on average once every 1.5 to 2 years. These are the flows most linked to channel bed formation and maintenance. The model (winxspro) estimated that bankfull flows transport approximately 1860 tons per day through this cross-section. There has been no measurements of bedload sediment transport taken to validate this estimate.

F. Water Quality - Temperatures

Summer-time water temperatures in R&R and the West Fork exceed the 64 degree (F) State standard for many days during the season. These high temperatures are likely a natural, background condition, although they are likely somewhat exacerbated by harvest in the headwaters of the South Fork of Rough and Ready (WF WA, physical science report, pg 9). It is not likely that the small amounts of sediment currently supplied to the creek from disturbed areas are affecting the stream temperatures in the mainstem. The sparse riparian forests likely block some incoming solar radiation and prevent even greater warming. The influence of Port Orford Cedar on stream temperatures is not quantified, but is not expected to be high given the sparse distribution of this species.

G. Water Quality - Hazardous Materials and Dissolved Elements (geochemistry)

Sources of hazardous materials in the watershed currently come from vehicles crossing at the existing fords, and from homes and industrial uses in the watershed. There are no known spills of hazardous materials nor dumps in the area. There is some existing risk associated with vehicles crossing the fords as they could leak hydraulic fluids and gas/diesel during the crossing.

The geochemistry of the surface waters (9 sites) and the chemistry of the bed sediments (8 sites) in R&R Creek was studied as part of a monitoring program established by the US Geological Survey. They found that pH values ranged from 7.63 to 8.58, conductivity from 120 to 277 uS/cm, and that alkalinity ranged from 75 to 182 ppm. Additionally, “the concentration of elements that may be a concern for aquatic and public health are generally low, particularly for Copper, Zinc, Arsenic, Cobalt, Selenium, Moblbdium, Uranium and nitrates” (Miller et al, 1998). “The only exception is Nickel...which is elevated relative to average fresh water” values (ibid). Nickel occurs in concentrations that exceed state ambient water standards (sample values 11-36 micrograms per liter, state standards 13.4 micrograms per liter; Table 20, DEQ, 1992) “High alkalinities...indicate good capacity for buffering acid generation from possible sources such as acid rain and acid-mine drainage”(Miller et al, 1998).

Several springs currently being used as domestic water supply were sampled at the request of landowners who live down grade of proposed mining site B. The results of those analyses are included in the project files. The majority of the elements sampled exisited in concentrations so low that the equipment was unable to detect the element. Nickel, again is in concentrations higher than allowed under state drinking water standards (sample values 30-40 micrograms per liter, state standards 13.4 micrograms per liter).

II. Chapter 4 - Effects of Alternatives

A. Soils and Geology

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Changes in local site conditions, including unique locales
2. Risk of slope instability.
3. Additional mine development
4. Toxicity of the Ore

<u>Issue 1. Changes in local site conditions.</u> Which pits are  developed and the miles of road required to access those pits will vary by alternative. The amount of land disturbed to generate road surfacing rock is proportional to the number of road haul miles.  Use of this land as a rock pit creates an irretrievable committment of resources, once the rock is quarried and used, the rock pit can not be returned to its former configuration.

The locations and conditions at each of the mining pits and along the roads have many features in common, as well as a few that are unique to each locale. In general, the pits and the access roads traverse largely ultramafic-derived soils, although there are some road miles on the alluvium. Disturbance to the surface layer of these soils will expose the sub-soils, and displace the relatively organic-rich surface layer. This loss of soil structure and mixing of soil horizons will likely result in reduced productivity at these sites, as observed at disturbed sites in the area that have not revegetated quickly and are visible for many years following disturbance.

The mining pits will be filled back in with waste rock and covered with the reserved topsoil following excavation. The mining pits will remain as topographic depressions whose depth will be approximately 6' below current elevation. Mining pits will likely fill with water during some of the year, changing which plants will chose to colonize these sites, as compared to pre-disturbance conditions. The mining pits will be drained such that standing water levels will remain below the placed topsoil, see sketches below.

Mining pit drainage  is contingent on the slope of the hillside into which the pits are dug.  Drains on sloping hillsides will be able to be installed with a minimum of excavation (sites C and D). Drains on more level sites (A and B) are not feasible due to the great distances that would have to be excavated in order to ‘lose’ enough elevation such that the pipes would flow downhill. These sites will likely be designed with a simple armored outflow. These sites are more likely to experience ponded conditions. I recommend that final designs be prepared by a certified engineer hired by the proponent prior to final approval of any plan of operation.

The following table displays the amount of disturbance by alternative. This table represents direct effects to local soil productivity and structure at each site.It is important to recognize that the disturbance associated with this proposal will ‘set back’ any recovery that is already occurring.

| | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Miles of road in project area | 15.7 (not all miles drive able) | 14.3 | 15.5 | 15.4 | 13.3 | 0.0 | 14.3 | 9.6 |
| Acres of Pit Developed | 0 | 35 | 35 | 35 | 33 | 0.5 | 20 | 20 |
| Acres of Storage Area | 0 | 5 | 5 | 5 | 5 | 10 | 5 | 5 |
| Total Disturbed Acres | 48 | 83 | 87 | 87 | 73 | 10.5 | 85 | 58 |

The indirect and cumulative effects are that the total number of affected acres are at a lower level of vegetative production than undisturbed habitat. Given Hotz’s (1964) estimate that the Josephine sheet covers 400 sq miles (256,000 acres), none of the alternatives should dramatically affect the overall soil structure and productivity on the Sheet. Cumulative impacts to site conditions should the miner have access to the full 512 acres believed to be reasonably foreseeable are the additional disturbance at the pits and in the likely much larger size of the stockpile site. These increases would take more land out of vegetative production, as well as have additional impacts as discussed under each issue in the text that follows.

There are several ‘unique locales’ that will be affected by the alternatives. Specifically, the small wetland associated with a spring at crossing # 6 (colloquially referred to as yellow legged frog pond), and Alberg Creek are important to note. It is difficult to quantify effects to these sites, but raw acreage counts as above may not adequately capture effects either. The wetland near crossing # 6 is discussed under section B. Channel Form and Riparian Ecosystems further on in this report.

The direct effects to local site conditions and soil productivity are the same in Alberg Creek under all alternatives *except* the PA. The currently degraded condition of the stream side road will persist for some time; although recovery (revegetation and armoring of the surface) will also begin to occur. This road occupies the riparian area and makes that land unavailable for production of riparian forests. It is badly eroded, water flow goes down the road or the creek dependant upon water levels and shifting bed elevations. Under the Proposed Action, this road would be re-built. This would further delay any recovery of riparian forest. It is also very likely that the road would be subject to failures in the future, an issue that is discussed in section E. Water Quality - Sediment.

Issue 2. Slope Stability. As previously noted, slope stability issues have not been identified as the dominant erosion process in Rough and Ready. However, the issue of hillslope stability associated with creation of the mining pits has raised concerns.

The potential accumulation of water in the newly created pits could result in mass failures. This accumulation will occur when the input of water from rain or surface runoff exceeds the infiltration rate in the pits. Infiltration in the newly created pits will be affected by many variables, most of which are not quantified. Those variables are: depth to bedrock, number, permeability and location of fractures in the bedrock, rainfall and runoff rates, and hydraulic head.

Ponded water will exert both downward and lateral stress on the soils (Sowers, 1979, pg 576). There is the greatest potential for site failure when the pits are located on steeply sloping lands such that there is a thin ‘wall’ of soil and rock that is serving as one side of the pit. None of the sites have been modeled for slope stability. At proposed pit locations A and B little risk is anticipated because the pits will be excavated into fairly level hillslopes such that no ‘thin walls’ will result. At site C, slopes are a bit more steep than at sites A&B, and are less steep than slopes at site D. Slopes are site C are expected to be stable both before, during and after the operation.

The slope steepness and proximity of mine site D to the South Fork of R&R has raised concerns regarding slope stability at this location. The risk associated with this issue has not been quantified, but is higher under alternatives PA, 6, 7, 10, and 11 than under the no-action alternative and alternative 8, where no development would occur. In terms of risk, alternative 9 lies intermediary to these end members, as some sampling would occur. The risk associated with alternative 9 is very low and mimics that associated with the no-action and alternative 8 with respect to slope stability. Local site productivity in the event of a failure would decrease as accumulated soils would be lost and the site would be converted to sub-soil and/or bedrock.

In addition to slope stability concerns developing directly adjacent to the pits, concern has been raised about the potential for changes in groundwater flow such that slope stability some distance from the pits is altered. This situation is possible, but is believed to represent a low risk. The anticipated low risk stems from the observation that this is a very ancient landscape with well-developed weathering that has been subject to much wetter conditions that occur today. Localized increases in groundwater that move beyond the pits are likely to simply be absorbed into the larger groundwater network and not result in mass failures.

Water that may accumulate in the pits could also exceed the holding capacity of the pits and spill out over the top. This would likely result in gullying of the hillslope at the point of exit. The sediment eroded from the gully might then be delivered to the stream system. This risk can be mitigated through the design of an exit point that is armored and does not drain toward any streams or unstable slopes. Addtional mitigation will include an engineer-designed drainage system that will drain the pits such that there is no standing water in contact with the placed topsoil, save during those hours when precipitation rate exceeds the soils ability to absorb the water (infiltration rate). These drains may only be feasible at sites C and D where the ground slope will allow for the drain pipes to intersect the hillslope at at a reasonable distance from the pits. The more level sites (A and B) would require very long pipes that would require extensive excavation to install. The outlet amoring is still necessary as the drainage system will be artificial and will have some risk of failure associated with it. See the sketch above that details the anticipated schematic design of the pits. All action alternatives run an equal risk of this occurrence.

The indirect and cumulative risks associated with slope stability and gullying are the potential introduction of sediment to the stream. Given the predicted low risk and low incidence of slope instability, it is very likely that the stream would sort and transport the failed material through the reach. The potential effects of mining a total of 512 acres (the estimated acres in the reasonably foreseeable cumulative effects) on slope stability are most notable at site D. Additional development on this slope would increase the risk of failure. There is also some potential that slope stability issues could be encountered at site C should the acreage expand into steeper slopes at that location. Overall, the risk of encountering additional slope stability related impacts is low, as the laterites by their very nature tend to reside on gentle sloping surfaces.

Issue 3. Additional mine development.  As previously noted, there are additional lateritic soils that are relatively enriched in metals in the immediate vicinity. This area also resides within a larger regional context or which metals-rich sites are known. For purposes of this SDEIS, the hypothesizing regarding potential future development is limited to those areas that considered reasonably foreseeable. The 35 acres of pits are nested within larger areas explored by Ramp in 1978. The total area of these is approximately 512 acres.

Should the proponent be successful in establishing access, especially road access, to all four locations given under this proposal, it would be reasonable to conclude that the opportunity to mine the additional 477 acres (512 minus 35)would exist. Mining is, of course, a matter of the market, so timing is impossible to predict. The effects of mining an additional 477 acres would need to be studied on a site specific basis. It would be reasonable to conclude, however, that slight increases in risk to slope stability, increases in sediment production, and decreases in soil productivity would occur. Additionally, the effects of these upon water quality and quantity would likely be more dramatic than the effects that will be described in this analysis.

Issue 4. Toxicity of the Ore. The laterite ore is a product of deep weathering. These materials have been in contact with oxygenated surface waters for millennium. There are no chemical reactions in this physical extraction save increased weathering as a result of freshly fracture surfaces. Freshly exposed surfaces will not present any new elements to the environment that have not previously been present in this watershed. Total dissolved loads would increase as these fresh surfaces supplied Fe, Ni, Si and other elements

The no-action alternative provides the least risk to the environment in terms of increasing the availability for dissolved elements to enter the surface and ground waters of this watershed. The remaining alternatives pose a risk proportional to the number of mine pit acres they expose, as shown in the table below. "The mining of the laterite should present no problem to the chemical quality of waters within the watershed." (Miller et. al., 1998). However, due to concerns about the chemical breakdown of olivines within the peridotites, "...the use of peridotite as road material should be avoided." (Miller et. al., 1998). The risk is then also portional to the miles of road surfacing on the haul route with peridodite materials, this is also given in the table below. Alternative 9 and the No Action will not increase nickel concentrations in the surface nor groundwaters. The Proposed Action, and alternative 6, 7, 8, 10, and 11 may result in increases in nickel concentrations. These increases may not be measureable, but the processes are present under these alternatives that would trend the watershed towards the production of soluble nickel. Those action alternatives that may result in increases in nickel may not be permitted under statutes of the Oregon Department of Environmental Quality.

| | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Acres of Pit developed | 0 | 35 | 35 | 35 | 33 | 0.5 | 20 | 20 |
| Haul Route Miles | 0 | 14.3 | 15.5 | 15.4 | 13.3 | 0 | 14.3 | 9.6 |
| Road Construction (miles) | 0 | 0.55 | 3.8 | 4.2 | 4.2 | 0 | 1.4 | 1.25 |
| Road Reconstruction (miles) | 0 | 7.7 | 6.1 | 5.5 | 4.9 | Minor | 8.8 | 6.0 |

There are no known occurrences of sulfides in the project area (Koski and Derkey, 1981) such that the many, well-documented problems associated with sulfide mining such as acid mine drainage will occur.

The indirect and cumulative risks associated with toxicity of the ore should the proponent mine the full 512 acres would be contingent on both the volume processed and on how that ore is accessed. It is likely that more road development would occur, hence increasing the potential weathering of the road surfacing rock (especially if peridotite rock sources are used). Additionally, 512 acres while still not large compared to the size of the Josephine sheet, may be enough disturbance that dissolved element concentrations could become measurable. A detailed geochemical analysis would likely be required to analyze this possibility should the proponent propose this level of activity in the future.

B. Channel Form, Riparian Ecosystems

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Changes in Channel Form, mainstem and tributaries
2. Direct Impacts to Habitat
3. Potential Loss of Port Orford Cedar from Riparian Ecosystems
4. Changes to wetlands and springs.

Issue 1, 2, &3. Changes in Channel Form, and POC, mainstem. There are no anticipated changes to overall channel form from either the no action, nor any of the action alternatives in the mainstem of Rough and Ready Creek. This system is a high energy system with high stream power such that any material placed in channel or moved around in the channel by humans is relatively insignificant compared to the power of the creek itself. However, there will localized direct effects to fish and invertebrate habitat that will be discussed under the aquatic biology section.

There would be localized impacts to bed and banks in the alternatives that construct road crossings. The channel that drains No Name creek migrates during storms, while this area would be avoided, some erosion could occur during events that overtop the banks.

Reductions in large wood due to the potential for mortality associated with root disease would not dramatically affect channel form. Changes to stream temperature are discussed under water quality -temperatures.

Issue 1, 2, & 3. Changes in Channel Form, and POC, tributaries. Changes to tributary channels will vary by alternative. There will be direct effects to habitat at all locations where fill is placed in channels. The re-construction of the Alberg road under alternative PA would further delay the recovery of this channel, and add sediment to the system when it inevitably fails during large storm events. The West Fork Illinois tributaries are not expected to change in channel form under any alternative , aside from direct impacts as a result of the one crossing in the headwaters of Rock Creek. The table below details the number of tributary crossings planned for each alternative.

| | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Number of fills placed in tributaries | Existing Crossings: 4 in Ahlberg, 1 on No-name. | 9 | 3 | 3 | 2 | same as No Action, 1 round trip use crossing on Rock Creek in Section 33 | 1 | 3 |

The direct effects of the potential loss of Port Orford Cedar in the tributaries could be two-fold: temperature changes and wood available for metering of sediment transport. Large wood is not transported out of the tributaries very easily, generally a debris flow is required to move material of this size from smaller drainages. Thus the residence time of the existing Port Orford Cedar in the tributaries is long. The real effects will be noted some centuries from now when the existing supply has finally rotted and no replacement stand has grown. At that time, an increase in sediment transport might be noted.

A review of floodplain mapping shows that neither the stockpile location suggested under the PA, nor the location proposed under the remaining action alternatives lies within the federally mapped 100 year floodplain. However, under the placement of the stockpile under the PA is adjacent to an overflow channel that is visible on air photographs, this area lies within the riparian reserve of Rough and Ready Creek. This concern is mitigated by moving the location under all other action alternatives.

The indirect and cumulative effects of channel changes and the loss of Port Orford Cedar to Rough and Ready Creek, as well as to the West Fork of the Illinois River are not expected to be measurable. These systems are large and wood is transported much like sediment. There will be a slight loss in the amount of wood available for micro-sites should the Port Orford leave the system and not be replaced. Should the operation expand to include the full 512 acres considered as the potential reasonably foreseeable cumulative acreage, changes in channel form are not expected. This is due to the fact that the sites lie well away from drainages, and that any additional road development required for the 512 acres is likely to occur on ridges.

Issue 4. Wetlands and Springs. The effects to wetlands and springs will vary by alternative. The wetland/spring complex near crossing #3 will be affected by alternative PA only. Re-construction of a road in this area will disrupt flow patterns, exact results can not be predicted, but it is likely that some wetland habitat will be displaced and some may be lost.

The direct effects to the wetland located near crossing #6 under the No-Action alternative and action alternatives 8, 9, 10, and 11 are that the habitat conditions are currently disrupted and will likely continue that way if no actions are taken. Under any action alternative than maintains road access to site D, a continued supply of fine sediment from road use and maintenance may affect this wetland. Further down-cutting of the road surface could change surface and groundwater distributions in the vicinity of the wetland. Alternatives that propose road access to site D include the PA, and Alternatives 6 and 7. The cumulative effects associated with this site are difficult to assess as the total population of small wetlands in the project area is not known.

Bedrock springs that are recharged by deep ground water sources are not expected to be influenced by this project. This assertion is made after reflecting on the relatively small size of the pits given the groundwater influence area for the springs. Because deep groundwater flow paths are not precisely known (nor is it possible to map them), this element must be assessed in terms of risk. The risk of change to spring water quantity and quality under the No-action alternative is slight, and is contingent on geologic process or perhaps the occurrence of wildlife and/or changed climatic conditions. Under the action alternatives, the risk of change is low, and is lowest under Alternative 9 due to the lowest levels of disturbance. Pre- and post- operation conditions could be monitored to validate or refute this assertion.

Changes in surface and groundwater flow as a result of road construction may also effect changes to wetlands. There are other locations on the district where road surfaces accumulate water and water-associated vegetation begins to occupy the site. It is not possible to predict exact locations where this might occur as often these waters are not visible until construction has begun. It is equally possible to ‘de-water’ some previously wet sites through road construction. There are no known sites, however where the planned road construction will cross wetlands. This statement does not include the crossings of Alberg Creek, those are discussed under section E. Water Quality - sediment further on in this document.

The indirect and cumulative risks associated with wetlands and springs should the proponent mine the reasonably foreseeably additional 512 acres are that potentially additional seeps and springs would be intercepted by a more extensive road system and that effects to groundwater may occur. The 512 acres are clustered near the existing proposed sites, expanding the pits from 10's of acres to 100's of acres in size may disrupt local groundwater flow paths.

## C. Surface and Ground Water Interactions

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Changes in the hyporheic zone in mainstem Rough and Ready.
2. Changes in the hyporheic zone in tributaries.

<u>Issue 1. Changes in the hyporheic zone in mainstem Rough and Ready</u>. Changes to the hyporheic zone in R&R could result if there was large-scale channel aggradation or degradation, influx of foreign fluids or materials, or shifts in channel location. The analysis does not predict any broad changes to channel location nor bed surface elevation as a result of this proposal. The influx of foreign material and fluids is considered to be a low risk, although it is recognized there are important consequences should this risk become a reality (see section G. Water Quality - Hazardous Materials and Geochemistry). The risk to the hyporheic zone mimics the risk of spill and follows that analysis. The ranking of the alternatives from most to least risk is: PA, 6=7,8,10=11,9, no action.

<u>Issue 2. Changes in the hyporheic zone in tributaries</u>. Changes to the hyporheic zone in the tributaries to R&R and the West Fork could result if there was large-scale channel aggradation or degradation, influx of foreign fluids or materials, or shifts in channel location. With the exception of Alberg Creek under the PA, the analysis does not predict any broad changes to channel location nor bed surface elevation as a result of this proposal. The PA will continue to delay the recovery of this tributary. The influx of foreign material and fluids is considered to be a low risk, although it is recognized there are important consequences should this risk become a reality (see section G. Water Quality - Hazardous Materials and Geochemistry). Therefore the PA poses the highest risk to the hyporheic zone in Alberg Creek, no risk is anticipated in this drainage under the remaining alternatives.

Because the direct effects associated with this issue are so small and are not expected to be measurable, there are no anticipated measurable cumulative and indirect effects anticipated to the hyporheic zones of the West Fork of the Illinois River. This is anticipated to hold true even if the proponent mines the reasonably foreseeable 512 acres.

## D. Water Quantity - Flow

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Changes to Peak Flows.
2. Changes to Low Flows.

Rough and Ready Creek supplies approximately 36% of the flow volume in the West Fork Illinois at its point of entry into the West Fork. Overall, it supplies roughly 30% of the flow. These flow estimates are made substituting acreage as an estimator of flow, as no continuous flow data is available to base the relative contribution upon. Based on observations, surface water contribution to the West Fork is likely lower than 36%, but sub-surface contributions may ‘make up’ the observed difference.

<u>Issue 1. Changes to Peak Flows</u>. Changes to peak flows are generally not anticipated to be discernable either in the tributaries nor in the mainstem of R&R. This is due to the fact that the road system will be designed for drainage that does not concentrate flow and deliver it to the streams. While the risk is very low to non-existent any alternative, it is higher under those alternatives that reconstruct and use the greatest number of road miles. The ranking of the alternatives with regard to this issue , from lowest risk to highest is: No Action, #9,#11, #8, #10=PA, #7, and #6.

Compaction of the stockpile site may result in storm water runoff that will require engineering to properly disperse. Under any action alternative, this runoff will be designed to exit the site to a location that will minimize water and sediment delivery to the stream. There is a low risk associated with this issue under any alternative, but the ranking from least to highest risk is: No Action, #6=#7=#8=#10=#11, #9, PA. This is because the PA proposes a larger stockpile site that is closer to the mainstem of R&R than any of the other alternatives.

<u>Issue 2. Changes to Low Flows.</u> Changes to critical summer low flows could result if water withdrawals are associated with this project. One proposal for resolving the issue of dust on the roads has been to use water. The water source for that dust abatement could be R&R creek itself, or any number of other sources. The interdisciplinary team considered the use of other dust abatement techniques that would not require the use of water. These techniques might include paving, lignan, or various salts. The team felt that water use was the best of the choices in order not to introudce foreign materials into the watershed.

The estimated daily use of water will vary as a function of road use, air temperatures, soil moisture, humidity and road miles. For this analysis road miles are used as the basis of comparison as the other variables can be assumed to be relatively constant over a given day. Additional water (approximately 70 gallons per piece of equipment) would be required for equipment washing and for the stockpile site. Specific information on these items are not available from the miner and as such are not displayed here.

Roads are assumed to be 20' wide, and water use is 0.2 gallons per square yard. Watering is assumed to occur 2 times per day for all haul miles. Both the total estimated gallons of water and the percent of an August low flow value by alternative is displayed below. A water right would be required by State law if this water was taken from any stream in the area. None of the action alternatives appear to withdraw enough water that aquatic values would be significantly and directly effected. This statement is distinct from the recognition that any reduction in water flow **trends** the watershed toward a degraded condition with respect to flow and temperature. This trend, while not measurable is in conflict with the goals of State Water Quality standards and the TMDL process. The direct risk is clearly lowest with the No Action and Alternative 9. The remaining alternatives are all very similar in terms of risk.

| | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Gallons per day | 0 | 40264 | 43643 | 43362 | 37449 | 0 | 40264 | 27030 |
| Percent of Low Flow (a 4cfs late August value) | 0 | 1.56 | 1.69 | 1.68 | 1.45 | 0 | 1.56 | 1.05 |

One effect of decreasing low flows would be to trend toward exacerbating already high stream temperatures and potentially affecting aquatic organisms. The degree to which temperatures would be directly affected could be modeled, and would be in proportion to the quantity of flow taken. Further exacerbating stream temperatures is in conflict with Oregon State Water Quality standards and therefore a violation of the Federal Clean Water Act.

The indirect and cumulative effects of increases to peak flows are not expected to be discernable at the scale of the West Fork of the Illinois River, nor any point downstream. Cumulative impacts to peak flows should the miner have access to the full 512 acres believed to be reasonably foreseeable are still expected to be negilible. This is because the additional road system development would likely occur largely on ridgetops and the pits would likely be designed to drain at a variety of locations, reducing the likelihood that a large volume of overflow would become available to stream system simultaneously.

The indirect and cumulative effects of decreasing low flows are more difficult to estimate. Alternatives that call for potentially more water withdrawal would result in that much less water being delivered to the West Fork through either surface or sub-surface pathways. This could effect the same issues in the West Fork that are critical with regard to low flow, temperature and aquatic habitat. Once again, our inability to measure those effects at such a fine scale is likely to obscure our ability to predict the consequences directly. The trend would not be favorable for aquatic health, however. Cumulative impacts to low flows should the miner have access to the full 512 acres believed to be reasonably foreseeable are expected to further continue the trend toward decreasing water quality. It is likely that the trend would be measurable due to the additional water needed for dust abatement, the larger stockpile site and the more vehicles that would require washing.

E. Water Quality - Sediment

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Erosion from Hillslope roads
2. Erosion from Stream Crossing fills, mainstem and tributaries
3. Erosion from mining pits and stockpile site
4. Transport of bedload sediments, channel form
5. Sediment Supplied due to Helicopter Loads

The beneficial uses that are protected in Rough and Ready Creek are: Domestic water supply, industrial water supply, irrigation, livestock watering, anadromous fish passage, salmonid fish rearing and spawning, wildlife, hunting, fishing, primary contact recreation (swimming), and hydro-power.

The beneficial use of domestic water supply is currently being met. Dissolved concentrations of nickel are elevated in surface and spring waters realtive to state ambient water standards. As discussed elsewhere in this report, all action alternatives save Alternative 9 are expected to further degrade this condition.

The beneficial use of salmonids is discussed in the aquatic portion of the FEIS.

The benefical use of ‘swimming’ is expected to be affected only under the PA with regards to sediment introduced during ford construction. There is also some risk to ‘swimming’ under the helicopter alternative in the event that a bucket of mined material is dropped into a creek. This risk is believed to be low and is discussed elsewhere in this report.

Point source pollution from many mines are regulated through the National Pollution Discharge Elimination System (NPDES). Potential pollutants from this project are better understood as non-point source pollutants. Non-point sources are regulated through the use of Best Management Practices if the stream waters are meeting water quality standards. Those water quality parameters that exceed state standards (under the non-point source side of the equation) are subject to the TMDL process (total maximum daily load). The TMDL is an allocation process that sets defineable methods and goals for recovery of affected parameters.

<u>Issue 1. Erosion from Hillslope roads</u>. As previously discussed, road construction and use is likely to generate sediment in two ways: loose material that is washed off the road surface during storms, and dust that is blown or carried off the road by vehicles. This sediment becomes relevant to water quality only after such time that it is delivered to the channel. Sediment delivery is likely to be much less than production for a variety of reasons; most importantly due to the relatively few number of places hillslope roads cross stream channels and to the proposed design criteria. In all cases it is recognized that erosion of roads is proportional to use, use considers ore trucks, service vehicles, administration vehicles and incidental trips by concerned citizens and other visitors to the sites.

Road segments that lie in proximity to stream channels pose the greatest risk of sediment delivery. Road fills placed directly in stream channels are covered under issue 2 in this section. The road segments that lie nearest streams are:

1. Road segment that accesses site D
2. Road segment that parallels the unnamed tributary in the w ½ of se 1/4 section 4, hereafter referred to as ‘section 4' tributary.
3. Road segment that parallels Alberg Creek (Alberg road)
4. Road segment of 4402-461 that parallels unnamed tributary to Rock Creek in the w ½ of sw 1/4 of section 34, hereafter referred to as ‘section 34' tributary.
5. New construction on the Bench Segment adjacent to Rough and Ready.
6. New construction between crossings 3 & 4

Of these six sections, the road segment that runs up Alberg Creek has the highest potential to deliver sediment due to its placement directly adjacent to the creek.

Existing poor drainage conditions along the section 34 segment, and to a lesser degree along the section 4 segment, make these two sections second in terms of risk. Finally, the site D access poses the lowest risk within these 6 segments. The table below identifies those alternatives that will use these road segments. In all cases road designs will be such that sediment delivery is minimized. It is very important to recognize that these road segments all exist currently and are the locations where sediment is being delivered currently. Road use and reconstruction would disrupt the armor layer that develops under conditions of low or no use and delay the on-going recovery of these site.

Table xx

| Road Segment (length) | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Alberg (5280') | | x | | | | | | |
| Section 34 (2800') | | | | | | x | x | |
| Section 4 (2200') | | x | | | | | | |
| Access to Site D (1000') | | x | x | x | | | | |
| Between crossings 3 & 4 (1580') | | x | | | | | | |
| Bench Road (2000') | | | | x | x | | x | |
| Estimated MAXIMUM Sediment Delivery from road segments above current levels | | 193 cubic yds | 19 cubic yds | 119 cubic yds | 100 cubic yards | 1-5 cubic yards | 154 cubic yds | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated sediment delivery from Crossings (see Issue 2) | | 585 cubic yds | 35 cubic yds | 39 cubic yds | 16 cubic yds | <1 cubic yds | 5 cubic yds | 12 cubic yds |

Clearly, the PA has the highest risk of any of the action alternatives, while the no-action and #9 and #11 offer low risks on these sites. Alternative 10 proposes uses of the section 34 segment with attendant risks of sediment delivery. Alternative 9 allows a few trips with a tracked vehicle, but no passenger vehicle could negotiate that road segment. Alternatives 6 and 7 would access site D using the existing road and likely contribute sediment to the mainstem and South Fork of R & R.

The amount of sediment that is anticipated to be generated at these sites can be estimated as a product of road width times the segment length affected. This estimate does not include gullying as mechanism for delivery, as locations where concentration will occur are difficult to predict when the road is design to prevent such an occurrence. The assumption that road width was 25' ( to include erosion from disturbed area), and that the depth of wash was 0.25" across the surface. Based on observations, this depth of wash is likely higher than would ever occur across an entire surface so the numbers presented here are likely maximum estimates. They are best used as a comparison between alternatives.

Sediment is also generated during road construction. Under this proposal, alternatives 7, 8 and 10 propose to construct a bench road adjacent to Rough and Ready Creek. It is very likely that during construction material will enter R & R from this site. This risk is not found under the remaining alternatives. It is not possible to accurately estimate the quantity of sediment that will be introduced, but given the length of the road and observations from other sites, it is assumed to be between 50-100 cubic yards of material. Some of this material will be fines, some will be coarse. Rough and Ready is capable of transporting this material through the system at high flows, but the material will likely remain where it falls during the summer and fall months. It is reccommended that in order to limit the introduction of sediment into the creek during bench road construction, that blasting NOT be used as a means to excavate the road prism. There are other mitigations available to reduce sediment introduction such as log cribs, special drilling and rock blankets.

The direct effects of sediment delivery from these segments, as well as airborne dust, and any other sediment that came from disturbed hillslope sources could impact stream temperatures, water clarity, existing water uses, and aquatic habitat. Effects are contingent on the season of delivery. Airborne dust will likely only be delivered during the summer months and is expected to be mitigated by some form of dust abatement. The majority of the sediment delivery will occur during winter storms, and most likely during the first few storms of the season and/or during extreme events.

Due to the fine-grained nature of airborne dust, it may be expected to settle on the water surface and be transported out of the system with the current. As such it is not expected to occur in such quantity to directly, indirectly, nor cumulatively affect stream temperatures, water clarity, existing uses nor aquatic habitat.

The estimated maximum amount of fine sediment above current levels delivered to channels was shown in table xx. While the lack of data regarding current levels makes it more difficult to assess impacts, there is an assumption that the current rates of erosion from these roads, while not desirable, do not affect the previously noted high levels of water clarity. Nor have their been any registered violations nor complaints from water users regarding water quality. It can therefore be assumed that the existing levels of erosion are not limiting attainment of beneficial uses.

The fine sediment washed off of road surfaces and into tributaries during storm events will not likely directly impact stream temperatures as it will be carried out of the system in transport during the wet months of the year when stream temperatures are not a critical issue.

The fine sediment washed off of road surfaces and into tributaries during storm events may negatively impact aquatic habitat, and water uses under the PA. The cubic yards associated with alternative 6 and 9, while not desirable is very likely not large enough to be measurable. Winter water clarity may be decreased by the PA, 7, 8, & 10, especially during the first storm of the season.

Cumulative impacts from hillslope roads should the miner have access to the full 512 acres believed to be reasonably foreseeable are that additional sediment will be generated as a function of likely additional road length and road use.

<u>Issue 2. Erosion from Stream Crossing fills, mainstem and tributaries</u>. Rough and Ready Creek and its tributaries will be exposed most directly to new sediment at the stream crossings where road fill be placed with the channel. Crossing construction will also result in sediment being supplied to the channel. Very little vegetation will need to be removed, however as the majority of the proposed crossing sites have been used in the past and the disturbance has already occurred. In all cases it is recognized that erosion of roads is proportional to use, use considers ore trucks, service vehicles, administration vehicles and incidental trips by concerned citizens and other visitors to the sites.

The surface of the crossing fill will consist of crushed rock of less than 3 inches, and fines washed out (“washed rock”). Road surfacing specifications call for rock with resistance to abrasion measured by the LAR test. No more than 35% of the material may degrade into fines under the action of traffic. For this analysis, it is assumed that the washed rock meets or exceeds this specification and that 35% of the material will degrade into suspended load-sized sediment. The volumes of fines generated for each alternative was estimated from the volume of washed rock at each crossing, assuming 35% of the material degrades to fines.  For those alternatives (PA) where summer flows are in contact with the road surface, fine will likely be transported downstream.

Prior to winter flow, it is assumed that 50% of the fines generated will not be recovered when the fords are removed and 10% of the fines will remain at bridge approaches. These fines will move as suspended load when the winter flows reach higher levels. The fine material is expected to have a very low clay content, and thus would settle out of water column rapidly.  This fine material will likely be transported during the first high-flow event of the season. It is not possible to know precisely, but it is likely that transport of the fines could exceed the '10% above background turbidity' clause under OAR 340-41-365, (2) (c). The operator may apply for a permit for exception from this clause as specified under OAR 141-85-100 et seq (Removal and Fill Permits, Division of State Lands).

Results of this estimation are shown in table xx. The PA has the highest rates of predicted fine sediment delivery and transport. The remaining action alternatives differ from the PA by an order of magnitude. Only the PA may be expected to measurably affect water clarity, aquatic habitat and water uses. Alternatives 6, 7, and 10 may affect clarity and to a lesser extent habitat and uses, but are not likely to be measurable. The remaining alternatives are not likely to supply enough sediment to have a measurable effect on any variable.

Direct effects to water clarity will be to increase sediment concentrations and turbidity, likely in excess of state standards under the PA. State standards for turbidity may be exceeded under alternatives 6, 7, and 10 also. State standards are not likely to be exceeded in the remaining alternatives.

Direct effects to aquatic habitat are discussed in a following section and may include changes to the biotic community should effects persist. Direct effects to water uses are most likely to affect those who move water through pumps and filters, or by those who consume the water directly with no filtration. Pumps and filters will require more frequent maintenance and replacement should water be withdrawn (likely domestic use only) during turbid winter flows. Turbidity may result in undrinkable water if water is left untreated.

Cumulative impacts from channel crossings should the miner have access to the full 512 acres believed to be reasonably foreseeable are not expected to be different in scope than those encountered under the existing analysis. This is because no additional crossings are anticipated. The impacts are however, likely to persist for a longer period of time as the crossings would be required to be kept in place and maintained for more years of operation.

Issue 3. Erosion from mining pits and stockpile site. Fine sediment may also be generated at the mining pits and the stockpile sites. These sites are generally situation well away from existing drainage such that erosion is likely to be very minor. The highest risk is associated with ponding of water during the winter months, water over-topping the edge of the pit and gully creation. Pit design will be such that an armored surface or other mitigation will guard against this source. Similarly, the stockpile location will be engineered to mitigate for this concern, it will designed to drain and the pile will be covered to avoid winter erosion. Sediment erosion from these sources is anticipated to be minor and less than 2-5 cubic yards annually at each site.

Indirect and cumulative effects of sediment on water quality to the West Fork of the Illinois and to the downstream system may include effects on aquatic biota, stream temperature and water uses. Due to high background levels of suspended sediment transport observed in the Illinois River system, there are no expected effects to water uses and stream temperatures. Additional sediment transport may, however detract from other recovery efforts currently on-going in terms of watershed restoration of sediment sources to the Illinois. Cumulative impacts from pit and stockpile erosion should the miner have access to the full 512 acres believed to be reasonably foreseeable are that more sediment could be supplied to the stream system. This is simply a function of increased acres of impact anticipated under a larger operation.

Issue 4. Transport of bedload sediments, channel form Under the PA, it is proposed to allow the 7 crossings of mainstem R&R to wash out each year. The amount of fill varies by location and ranges from 65 to 190 cubic yards. Computer modeling of one cross-section (near crossing 4) estimated 1860 tons per day move through that area at bankfull flows. It seems very likely that given the high stream powers observed on R&R that the washed rock placed at the crossings would indeed be dispersed downstream.

The direct effects of this dispersed rock are not expected to alter the existing bed topography nor channel form of R&R Creek during those years that bankfull flows are reached. Fill material may remain in place during winter seasons where bankfull flows are not achieved, this could result in fish migration issues as discussed further along in this document. It is likely, however, that in most years, enough erosion will occur such that some portion of the channel will be open for fish passage.

The indirect and cumulative effects of at least 10 years of rock placement and downstream dispersal may, however begin to be noticeable. Again, due to high stream powers channel bed elevation nor channel form will likely alter dramatically, but local adjustments to channel slope may occur. Cumulative impacts to bedload transport should the miner have access to the full 512 acres believed to be reasonably foreseeable are that channel form may be influenced if the proposal includes annual reconstruction of fords. The alluvial fan of R&R is already dramatically effects the position and confluence with the West Fork Illinois (Coleman, pers comm, May, 1998). Additional coarse sediment to R&R and its fan are not likely to change this relationship.

Issue 5. Sediment Supplied due to Helicopter Loads

There is a risk that loads carried by a helicopter could accidentally drop during transport. There is a very low possibility that these loads could drop and fall directly into the creek. Each load is approximately 2 cubic yards. This material is not desirable in the stream system and would likely result in turbidity in excess of state standards should it fall in during the summer months. Cumulative impacts related to helicopter loads should the miner have access to the full 512 acres believed to be reasonably foreseeable are that the opportunity for risk is proportional to flight time. Additional flight time would certainly be substantial if the operation were to mine the 512 acres using a helicopter.

F. Water Quality - Temperatures

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Effects of Sediment on...
2. Changes to spring and wetland habitat.

The effects of flow on temperatures were discussed under Water Quantity - Low Flows.

In the case of Rough and Ready creek and the West Fork of the Illinois River, water temperatures are currently known to exceed State standards. It is anticipated that a ‘natural condition assessment’ will be conducted to verifty the commonly held assumption that high water temperatures in Rough and Ready Creek are the result of natural conditions, and are minimally, if at all, exacerbated by management. The ‘natural condition assessment’ is one facet of the TMDL process required to meet State standards. The West Fork will not likely be handled under a ‘natural condition assessment’ as it is reasonable to believe that past management on private and publicly managed lands has affected water temperatures.

Issue 1.  Effects of Sediment on Temperature. The effects of sediment on stream temperatures was discussed for direct, indirect and cumulative impacts under section E Water Quality - Sediment. In general, it is not anticipated that stream temperatures will change due to sediment transport. This is because most of the sediment transport will occur during winter months when sediment will be carried out of the basin and temperatures are not in a critical state. Additionally, no changes are anticipated in bed elevation such that temperatures could be effected by a widening nor narrowing of the channel form.

The  water ponding that may be anticipated upstream of fords under the PA will increase stream widths such that more surface area will be subject to solar radiation. The amount of increased radiation will vary by site as a function of the geometry at that site. Generally, crossings with gently sloping banks (e.g. crossing 1) will have proportionally greater widths per rise in water elevation.  While widening at this site will not likely result in measurable changes in water temperature, it is not desirable. Only the PA proposes ponding at any location. If POC root disease is present in the watershed at the time the PA constructs fords, the potential for killing POC trees exists. These dead trees would no longer be able to provide shade at these locations. This effect is not predicted to have measurable effects on temperature, but the trend is toward warmer water. The remaining alternatives have no risk associated with this variable.

Issue 2. Changes to spring and wetland habitat.  Water temperatures measured in bedrock springs and gravel through- flow ‘springs’ were 5-10 degrees (F) cooler than the corresponding surface water temperatures (7/24/97). There has been some concern that changes, specifically burial via road construction at crossing 3, would effect summer water temperatures in R&R. Road construction in this reach is likely to displace, and perhaps permanently alter the flow of these cool waters into R&R. Given the low volume of flow and their non-measurable (7/24/97) effects on water temperatures that day, it is not anticipated that these changes will directly effect the water temperatures in R&R. These changes are nonetheless, not the desired trend in this water quality limited stream. Only the PA has this risk associated, the remaining action alternatives do not propose to alter this site. There are no anticipated indirect nor cumulative effects associated with this variable.

Issue 3. Potential effects following the potential loss of POC.  Riparian Forests serve to limit incoming solar radiation and prevent stream heating. Should POC be lost from these forests it will result in a loss of riparian shade. This effect will be most noticeable during the first few decade before other existing and/or replacement trees occupy the site. In many cases, the loss may be permanent. This will increase stream temperatures. It is not possible to know the precise amount of this increase without extensive computer modeling and tracking of the location of POC specifically. The risk of increase is proportional to the risk assessment by alternative given under the POC report.  The cumulative impact of the loss of POC in riparian zones as one moves downstream in the watershed is also to increase stream temperatures until such time as another tree occupies the site.

Cumulative impacts from sediment onto temperature should the miner have access to the full 512 acres believed to be reasonably foreseeable are not expected to be measurable. Summer flows already flow in such a wide shallow channel that it is difficult to postulate that reasonably foreseeable sediment introductions would change that configuration. Changes to temperature from potential water withdrawals associated with the full 512 acres are discussed elsewhere.

G. Water Quality - Hazardous Materials and Dissolved Elements (geochemistry)

The alternatives, including pit development and use, road development and use, and storage of ore, differ in their effects. The alternatives have been described elsewhere and only the points relevant to the following issues will be covered in this section:

1. Risks associated with spills
2. Risks associated with dissolved elements

<u>Issue 1. Risks associated with spills</u>. This risk is proportional to the number of exposure opportunities (vehicles crossing channels) and the risk of equipment failure at that moment(s). The consequences are dependant upon the beneficial uses of the water and its reaction to the material spilled.

The most easily identifiable hazard is hydraulic fluid and gas/diesel leaking or erupting during crossing. It is not possible to calculate this risk, but it is proportional to stream width (length of exposure to risk), flow (seasonal or perennial), notification and reaction times, equipment quality and equipment maintenance. The estimated number of times per year that a vehicle will cross a channel is given in the table below. Crossings of Rough and Ready pose more risk than crossing the tributaries as it is wider and runs water all year. The rank of the alternatives from most risk to least risk are: PA, 7, 6, 8, 10=11, 9 and no action.

| | No Action | PA | Alt 6 | Alt 7 | Alt 8 | Alt 9 | Alt 10 | Alt 11 |
|---|---|---|---|---|---|---|---|---|
| Number of yearly trips | 0 | 3390 | 5700 | 3390 | 3150 | 2 | 3100 | 1940 |
| Number of R&R crossings | 0 | 7 fills | 3 bridge | 3 bridge | 2 bridge | n/a | 1 bridge | 1 bridge |
| Number of tributary crossings | 0 | 10 | 3 | 3 | 3 | 1 xing in Rock creek | 0 | 3 |

The consequences of a spill are high, especially to domestic water use, especially in the event that the spill goes unnoticed and hazardous materials are ingested. This risk is considered to be low, but not zero. Compliance with state law would require reporting. The potential for material to enter the groundwater also exists. Transport through the groundwater net and porous spaces in the soil make it far less likely that contamination would affect many, if any human water uses. Impacts to aquatic biota are not known, but are assumed to be detrimental to individuals impacted.

The indirect and cumulative impacts of a spill are the potential for hazardous materials to be transported downstream.

Cumulative impacts from spills should the miner have access to the full 512 acres believed to be reasonably foreseeable are an increased risk of spill, but no change in increased impacts. The increased risk is associated with the additional vehicles, and longer period of operation for the full 512 acre operation.

<u>Issue 2. Risks associated with dissolved elements</u> The risks associated with potential enrichment of surface and groundwater by dissolved elements was discussed under section A. Soils and Geology. In general freshly exposed mineral surfaces may provide some additional dissolved loading to the system. With the exception of Nickel, the elements do not present any hazards to human health in the expected concentrations. Cumulative impacts from dissolved elements should the miner have access to the full 512 acres believed to be reasonably foreseeable are a likely increase in several elements, including Nickel. This would violate State Water Quality standards, as the existing condition is already above established safe drinking water

The effects on aquatic biota, including those from Nickel are below state standards currently and are not likely to increase dramatically. The indirect and cumulative effects of this additional dissolved load are expected to fall well within the natural range of variablilty given the drainage area of the West Fork of the Illinois River and any acreage downstream. Cumulative impacts to aquatic biota should the miner have access to the full 512 acres believed to be reasonably foreseeable are still expected to remain below state standards for Nickel. This is because the standards are an order of magnitude more tolerant (higher) for aquatic biota than for drinking water. A full geochemical analysis prior to implementation of more extensive mining would be required to confirm this assertion.